

Page

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provide a controlled melting temperature range not exceeding about 15°C above the eutectic melting temperature. The same is true of Claims 12 and 20 directed to a solder joint and soldering process, respectively.

The Ferrie're et al. reference discloses vastly different binary, ternary, and quaternary solder alloy compositions for different service applications and nowhere recognizes or discloses firstly that a ternary eutectic composition of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu exists, and secondly that the ternary eutectic composition exhibits a melting point of about 217°C that renders it a Pb-free electrical conductor solder.

Claims 6, 12, and 20 have been amended to include the ternary eutectic composition and variants thereof wherein the Sn, Ag, and Cu are varied to provide a melting temperature range not exceeding about 15°C above the ternary melting temperature. Applicants note that the Ferrie're et al. reference fails to disclose the ternary eutectic composition set forth in Claim 1 and also fails to disclose variation of Sn, Ag, and Cu to provide about a 15°C melting range. The Examiner states at the top of page 3 that Ferrie're et al. 's compositional range would include at least one composition with the melting range and phase distribution of the rejected claims. However, the Examiner ignores the lack of disclosure in the reference firstly of the specific ternary eutectic composition heretofore unknown and secondly the utterly vast combination of possible different alloying elements set forth in the reference without any teaching as to which particular alloying elements to use in combination and in what relative amounts to achieve Applicants' solder having recited melting temperature range.

Surely, the Examiner will appreciate that Applicants' claimed solder based on the heretofore unknown ternary eutectic composition and having the microstructure comprising beta Sn phase and both Cu-Sn bearing and Ag-Sn bearing intermetallic compounds dispersed in the matrix and imparting strength thereto is not remotely disclosed in the Ferrie're et al. reference. One

skilled in the art looking at the Ferrie're et al. reference is not apprised of Applicants' solder, solder joint and solder process set forth in Claims 6, 12, and 20. But for Applicants' discovery, a solder based on the ternary eutectic composition having the melting range and microstructure recited would be unknown and not available to those skilled in the art in need of a Pb-free solder.

Reconsideration of the rejection of amended Claims 6, 12, and 20 as anticipated by Ferrie're et al. reference is requested. Claims 9 and 16 depending from Claim 6 and 12, respectively, are believed patentable on the same basis as set forth for the claim from which they depend.

Claims 1, 2, 4-7, 9-14, and 16-23 are rejected under 35 USC 102(b) in view of the Japanese reference JA 42-18219.

Applicants believe this rejection is patently in error. In particular, the Japanese reference discloses in the abstract a soldering alloy consisting of 60-99% Sn, 0.2-10% Ag, 0.1-1.5% Cu, 0.5-20% Pb, 0.05-10% Al, 0.1-3% In, 0.3-20% Zn, and 0.01-3% Si. In Table II of the reference, solder alloys are disclosed having 10% and 50% Pb. In contrast, Applicants' Claims 1, 2, 4, 6-7, 9-14 and 16-23 recite a solder that is Pb-free and readily available at low cost as a result of avoiding indium (In) as an alloying elements as described at the bottom of page 5 and top of page 6 of the specification.

Moreover, the Japanese reference fails utterly to disclose a Pb-free electrical conductor solder, solder joint and soldering process wherein a heretofore unknown ternary eutectic composition consisting essentially of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu having a eutectic melting temperature of about 217°C is employed as set forth in Claims 11, 19 and 20, as well as variants of the ternary eutectic composition wherein the relative concentrations of Sn, Ag, Cu deviate from the ternary eutectic composition to provide a controlled melting temperature range not exceeding about 15°C above the eutectic melting temperature as set forth in Claims 6, 12, and 20.

The Japanese reference nowhere recognizes or discloses firstly that a ternary eutectic composition of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu exists, and secondly that the ternary eutectic composition exhibits a melting point of about 217°C that renders it a Pb-free electrical conductor solder.

The Examiner states in paragraph 4 of the Office Action that the reference compositional range would include at least one composition with the melting range and phase distribution of the rejected claims. However, the Examiner ignores the lack of disclosure in the reference firstly of the ternary eutectic composition and secondly the combination of large number of different alloying elements including Pb set forth in the reference without any teaching as to which particular alloying elements of Sn, Ag, and Cu to use in combination and in what relative amounts to achieve Applicants' Pb-free solder having recited melting temperature range.

The Examiner no doubt will appreciate that Applicants' claimed solder based on the heretofore unknown ternary eutectic composition and having the microstructure comprising beta Sn phase and both Cu-Sn bearing and Ag-Sn bearing intermetallic compounds dispersed in the matrix and imparting strength thereto is not remotely disclosed in the Japanese reference. One skilled in the art looking at the Japanese reference is not apprised of Applicants' solder, solder joint and solder process set forth in Applicants' pending claims. But for Applicants' discovery, a solder based on the recited ternary eutectic composition having the melting range and microstructure recited would be unknown and not available to those skilled in the art in need of a Pb-free solder.

Reconsideration of the rejection of pending amended Claims 1, 4-6, 9, 11, 12, 14, 16, 18-20, and 22-23 as anticipated by Japanese reference is requested. Depending Claims 4, 9, and 14 are believed patentable on the same basis as set forth for the claim from which they depend.

Claims 6, 7, 11-14, and 18-23 are rejected under 35 USC 102(b) in view of the Mizuhara reference (U.S. Patent No. 4 643 875).

Applicants disagree with this rejection. In particular, the Mizuhara reference discloses a tin based ductile brazing alloy having 35-95% Sn, 0.5-70% Ag, 0.5-20% Cu, 0.1-4% Ti and/or V and/or Zr, 0-5% Ni, and 0-2% Cr for bonding to ceramic under vacuum conditions. To this end, the reference requires the presence of one or more the reactive elements Ti, V, and Zr in the alloy.

In contrast, the rejected claims are based on the heretofore unknown ternary eutectic composition and the microstructure comprising beta Sn phase and both Cu-Sn bearing and Ag-Sn bearing intermetallic compounds dispersed in the matrix and imparting strength thereto without the need for reactive elements.

The Mizuhara reference fails utterly to disclose a Pb-free electrical conductor solder, solder joint and soldering process wherein a heretofore unknown ternary eutectic composition consisting essentially of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu having a eutectic melting temperature of about 217°C is employed and variants of the ternary eutectic composition wherein the relative concentrations of Sn, Ag, Cu deviate from the ternary eutectic composition to provide a controlled melting temperature range not exceeding about 15°C above the eutectic melting temperature.

The Mizuhara reference nowhere recognizes or discloses firstly that a ternary eutectic composition of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu exists, and secondly that the ternary eutectic composition exhibits a melting point of about 217°C that renders it a Pb-free electrical conductor solder.

As mentioned, the Mizuhara reference requires the presence of one or more reactive elements Ti, V and Zr. Brazing is conducted under vacuum conditions as a result. The compositional ranges of the reference are so broad as to provide no guidance to

Applicants' claimed ternary eutectic composition and variants thereof recited in the claims. Moreover, the Mizuhara reference discloses inclusion of Ni in the alloy composition. Applicants' solder is free of Ni as set forth on page 10 of the specification.

The Examiner states in paragraph 5 of the Office Action that the reference compositional range would include at least one composition with the melting range and phase distribution of the rejected claims. However, the Examiner ignores the lack of disclosure in the reference firstly of the ternary eutectic composition and secondly the large combination of different alloying elements including Ti, V and/or Zr set forth in the reference that are possible without any teaching as to which particular alloying elements to use in combination and in what relative amounts in the overly broad ranges set forth to achieve Applicants' solder having recited melting temperature range.

The Examiner no doubt will appreciate that Applicants' claimed solder based on the heretofore unknown ternary eutectic composition and having the microstructure comprising beta Sn phase and both Cu-Sn bearing and Ag-Sn bearing intermetallic compounds dispersed in the matrix and imparting strength thereto is not remotely disclosed in the Mizuhara reference. One skilled in the art looking at the Mizuhara reference is not apprised of Applicants' solder, solder joint and solder process set forth in Applicants' pending claims. But for Applicants' discovery, a solder based on the recited ternary eutectic composition having the melting range and microstructure recited would be unknown and not available to those skilled in the art in need of a Pb-free solder.

Reconsideration of the rejection of pending amended Claims 6, 11, 12, 14, 16, 18-20, and 22-23 as anticipated by the Mizuhara reference is requested. Depending Claims 14 is believed patentable on the same basis as set forth for Claim 13 from which it depends.

Claims 3, 8, and 15 are rejected under 35 USC 103 in view of the aforementioned Ferrie're et al. reference taken with the Naton reference (U.S. Patent No. 4 879 096).

The deficiencies of the Ferrie're et al. reference are discussed above.

Applicants fail to see how the Naton reference makes up for the deficiencies of the Ferrie're et al. reference with respect to Applicants' Bi level. Although the Naton reference involves a Sn-Ag-Cu-Bi alloy, the concentrations of the alloying elements of the cited references are so different from one another as not to be properly combinable. For example, the Naton reference excludes zinc and cadmium from the alloy while the Ferrie're et al. reference requires zinc. Moreover, the ranges of alloying elements of the Ferrie're et al. reference are so varied and different from those of Naton reference as to lead away from any combination of the references, especially by the Examiner's picking and choosing of one element from the Naton reference for use in the complex and varied alloys of the Ferrie're et al. reference.

Applicants request reconsideration of the rejection of Claims 3, 8, and 15.

Claims 3, 8, and 15 are rejected under 35 USC 103 in view of the aforementioned Mizuhara reference taken with the aforementioned Naton reference.

The deficiencies of the Mizuhara reference are discussed above.

Applicants fail to see how the Naton reference makes up for the deficiencies of the Mizuhara reference with respect to Applicants' Bi level. Although the Naton reference involves a Sn-Ag-Cu-Bi alloy, the concentrations of the alloying elements of the references are so different from one another as not to be properly combinable. For example, the Naton reference makes no disclosure of a reactive element such as Ti, V, and Zr required to be present in the Mizuhara reference. Moreover, the ranges of alloying elements of the Mizuhara reference are so varied and different from those of Naton reference as to lead away from any

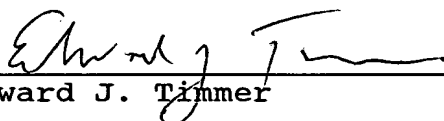
combination of the references, especially by the Examiner's picking and choosing of one element from the Naton reference for use in the complex and varied alloys of the Mizuhara reference.

Applicants request reconsideration of the rejection of Claims 3, 8, and 15.

New Claims 24-26 have been added and are directed to a Pb-free solder consisting of the ternary Sn, Ag, and Cu eutectic composition in ranges selected from the exemplary alloy compositions of the invention set forth on page 9, lines 18-20 of the specification. Due to the "consisting of" terminology, these claims exclude alloying additions such as Zn as set forth in the Ferrie're et al. reference, a transition metal as set forth in the Mizuhara reference, Bi as set forth in the Naton reference, and Pb as set forth in the JA 42-18219 reference.

Allowance of the pending claims is requested.

Respectfully submitted,

  
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